GROUND WATER REPLENISHER
(a system to artificially recharge ground water)

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Bachelor of Technology
In
Civil Engineering

By

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Department of Civil Engineering
National Institute of Technology
Rourkela-769008
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Under the Guidance of
Prof. S.P.SINGH

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CERTIFICATE

This is to certify that the thesis entitled **"***GROUND WATER REPLENISHER(a system to artificially recharge ground water)* **"** submitted by Sri Abhijeet Srivastava, Roll No. 10501027 in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Civil Engineering at the National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any Degree or Diploma.

Date: 11/05/2009 (Prof.S.P.SINGH)

ACKNOWLEDGEMENT

My heart pulsates with the thrill for tendering gratitude to those persons who helped me in completion of the project.

The most pleasant point of presenting a thesis is the opportunity to thank those who have contributed to it. Unfortunately, the list of expressions of thank no matter how extensive is always incomplete and inadequate. Indeed this page of acknowledgment shall never be able to touch the horizon of generosity of those who tendered their help to me.

First and foremost, I would like to express my gratitude and indebtedness to Prof S.P.SINGH, for his kindness in allowing me for introducing the present topic and for his inspiring guidance, constructive criticism and valuable suggestion throughout this project work. I am sincerely thankful to him for his able guidance and pain taking effort in improving my understanding of this project.

I am also grateful to Prof. M PANDA (Head of the Department) for assigning me this interesting project and for his valuable suggestions and encouragements at various stages of the work.
An assemblage of this nature could never have been attempted without reference to and inspiration from the works of others whose details are mentioned in reference section. I acknowledge my indebtedness to all of them.

Last but not least, my sincere thanks to all my friends who have patiently extended all sorts of help for accomplishing this undertaking.

ABHIJEET SRIVASTAVA

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CHAPTER 1

INTRODUCTION TO GROUND WATER REPLENISHER

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In the present scenario, talking practically, most of the residential areas, use ground water to fulfill their day to day needs. Till now nothing significant has been done to replenish the ground water except the 'RAIN WATER HARVESTING SYSTEM', in which the rain water is harvested and is then directed underground.

At present, the atmosphere has become so unpredictable that it is very difficult to consider that a particular region will receive the normal rainfall in the rainy season, also this rainy season is limited up to 3-4 months, so we can't rely only on rain, due to its high uncertainty, to replenish the ground water. Moreover the frequency of extraction of ground water is high and the replenishment from rain water is very limited. Thus some alternative must be thought of to overcome this problem.

It is found that about 70-80% of the household water goes into the sewer. The sewage thus carried to the treatment plant is treated to remove the harmful contents and the treated water is either supplied back for household purposes or to some other place, like industries etc, depending upon the quality of treated water. In this transportation, there is loss of water which can't be ignored. Further this treated water is not used to replenish the region from which water is extracted.

Thus in the current scenario: 'ground water is extracted for household purposes,70-80% of this water goes to the sewage treatment plant, treated water is circulated back, water is lost in transportation, this water is not used for ground water replenishment, thus there is a net loss of ground water'

'GROUND WTAER REPLENISHER' is an effort put in a direction to control this loss. 'GROUND WATER REPLENISHER' is a simple aligned system that can be laid out easily beneath the house.

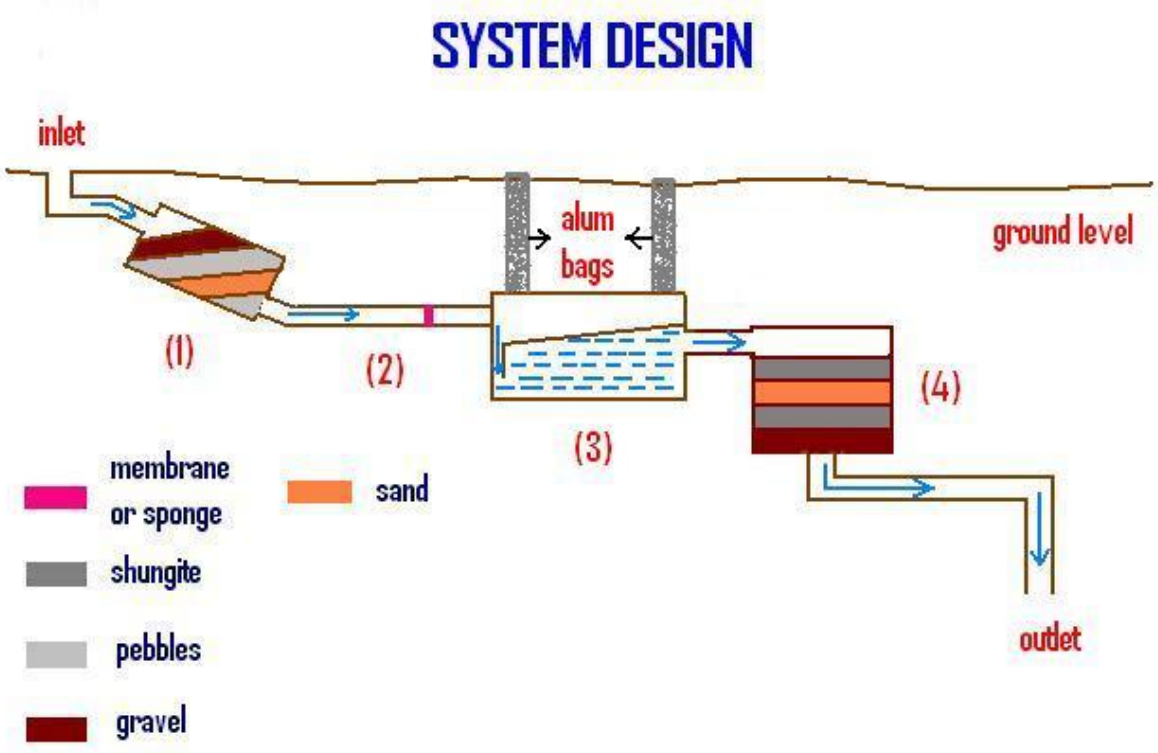
Excluding the sanitation dispose, remaining 40-50% of household water dispose - containing oil, grease, suspended dust particles, surfactants, heavy metals and some other pollutants - can be used effectively to replenish ground water after proper treatment, which may be carried out effectively using 'GROUND WATER REPLENISHER'

CHAPTER 2

DESIGN OF THE SYSTEM

DESIGN OF THE SYSTEM

'GROUND WATER REPLENISHER' is a simple alignment that can be laid out easily beneath the house requiring little space and a one time nominal investment. Also the house holder needs not to go for a regular checkup and maintenance of the system. Materials used in this system are natural and easily available, therefore it does not put an extra burden on the house holder. This system, which is basically an assembly of filtration systems, can be characterized by the four sections as shown in the fig.



2.1. The first section consists of a primary filtration chamber. This filtration system, also used as primary filtration in water treatment plants, is made up of coarse gravel, pebbles and sand. (fig 1-1)

2.2. The second section, which is an optional one, performs the task of removing extra oil present in the house hold waste water. Installation of this section depends on the amount of oil and grease that is normally flown out from the house as waste. Thus this section entirely depends on the lifestyle of the house holder. (fig 1-2)

2.3. The third section can be further divided into two parts (fig 1-3)

2.3.1. The first part is a mixing chamber. This chamber is so designed as if it behaves like a blender to mix water with the materials, required to be mixed to carry out the filtration process successfully.

2.3.2. The second part is basically a chamber where water is allowed to stagnate, which is an important step in the filtration process. This chamber is made up of reinforced cement concrete structure and a special designed outlet valve to transfer water from this section to the last section of the filtration system.

2.4. This section is again a filtration chamber where the final treatment takes place and the water flowing out from this section is free enough from the pollutants and can be safely directed underground.(fig 1-4)

The injection of this water is done through a pipe which is bored halfway to the level of ground water after which water percolates of its own to the ground beneath and gets collected as ground water.

CHAPTER 3

HOW DOES THE SYSTEM WORKS

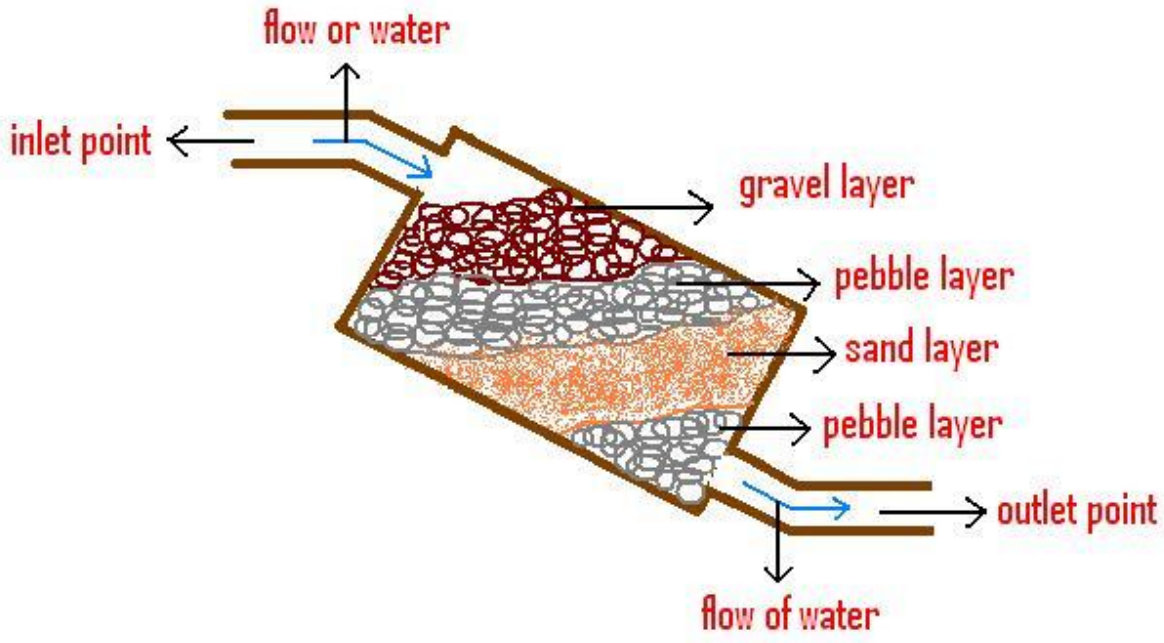
HOW DOES THE SYSTEM WORKS

As mentioned earlier, 'GROUND WATER REPLENISHER' is a filtration system where sequential removal of impurities and pollutants takes place.

The first chamber which is a primary filtration chamber, removes the heavy particles such as pieces of wood, coarse solids or some other solidified impurities, to some extent oil and grease. This chamber aligned at an angle but not vertically. Purpose of this slanted alignment is that it would require less vertical space, thereby reducing the overall depth of the system, thus making the installation of the system less difficult and more cost efficient.

It comprises of sand, coarse solids such as pieces of bricks, pebbles and gravels, all arranged in layers. Coarse solid is at the top followed by gravel, sand and finally pebbles. This layer of pebbles is provided to prevent the sand from being washed off with the water flowing through the system. An outlet pipe is provided to carry water to the next step of purification.

The chamber is as shown in the fig.



Typical performance of the this primary treatment is given in the table below

AVERAGE PROCESS REMOVAL (VALUES GIVEN IN TERMS OF PERCENTAGE REMOVAL)

CONSTITUENT	DATA SOURCE		AVERAGE
	A	B	
BOD	48	50	42
NH3-N	17	19	18
PHOSPHOROUS	27	26	27
ALKALINITY	+	+	+
OIL AND GREASE	67	63	65
ARSENIC	28	40	34
CADMIUM	30	45	38
CHROMIUM	+	44	44
COPPER	40	58	49
FLORIDE	+	X	X
IRON	43	42	43
LEAD	51	53	52
SELENIUM	0	0	0
ZINC	38	34	36
COLOR	18	12	15
TURBIDITY	31	30	31
FOAMING AGENT	30	38	34

+ = Increase

X= data inconclusive

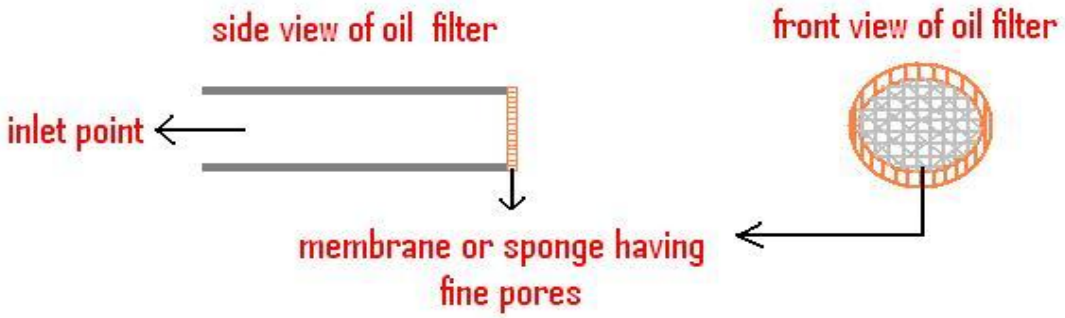
0 = no significant removal

REF : WASTE WATER REUSE AND RECYCLING TECHNOLOGY by GORDON CULP, GEORGE WESNER, ROBERT WILLIAMS and MARK V HUGHES Jr.

Though oil and grease is removed from the primary treatment section, it is not eliminated completely. Also the amount of oil and grease flowing out as waste varies from house to house depending upon the lifestyle and occupation of the house holder. To remove this extra oil and grease the second section which is an optional one can be installed.

Its design is very simple. Water coming out from the primary treatment chamber is passed through a pipe lying horizontally and a semi permeable membrane, allowing water to pass through it but restricting oil, is installed. In place of this semi permeable membrane we can also use a sponge having fine pores. Finally water is carried away through the pipes to the next section.

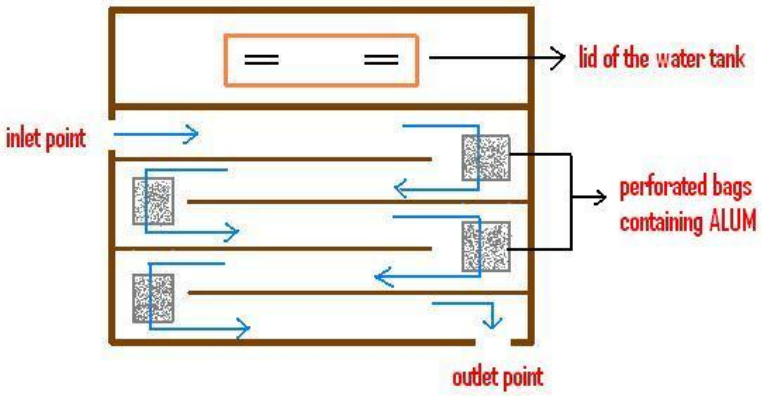
Design of oil filter is as shown:

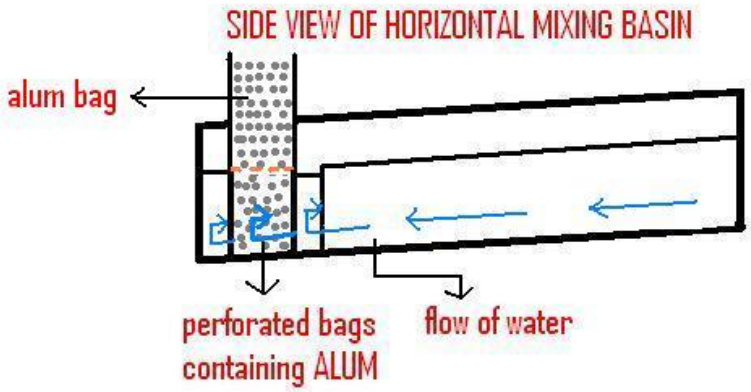


In this section basically coagulation and sedimentation takes place. Coagulant being used here is ALUM. As mentioned earlier this section has two parts-a mixing chamber and a chamber where water can stagnate for sufficient period of time.

As shown here, water in the mixing chamber is allowed to move to and fro on a slanting path, having powdered ALUM at each turn. It is found that for an effective coagulation to take place for normal house hold waste, having normal turbidity, speed of 1 foot per sec is sufficient enough for mixing of water with the coagulant. Since the coagulant is present at each turn, their quantity is so maintained so that after the final turn water has a coagulant concentration of 15-25 mg/lt. the amount of ALUM is maintained in the perforated alum bags by filling the coagulant bags with powdered ALUM. As the powdered ALUM present in perforated bags gets dissolved in water bags are refilled by their own with alum present in the alum bag.

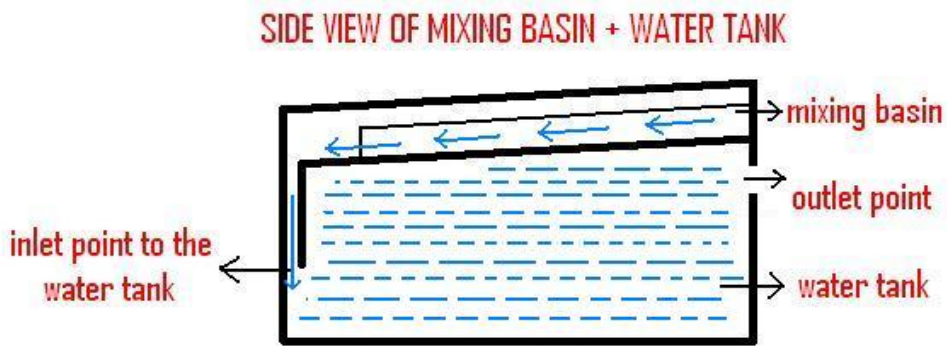
TOP VIEW OF HORIZONTAL MIXING BASIN + WATER TANK





From the mixing part water enters the chamber where water can stagnate for sufficiently enough period of time so that the impurities can settle down. The impurities and pollutants that are removed along with their percentage removal are listed in the table.

Whole chamber is as shown in the fig.



AVERAGE PROCESS REMOVAL (VALUES GIVEN IN TERMS OF PERCENTAGE REMOVAL)

CONSTITUENT	DATA SOURCE		AVERAGE
	A1	B1	
BOD	80	72	76
PHOSPHOROUS	-	78	78
ALKALINITY	13	19	16
OIL AND GREASE	91	87	89
ARSENIC	32	54	83
CADMIUM	68	76	72
CHROMIUM	81	90	86
COPPER	82	90	86
FLORIDE	46	42	44
IRON	84	81	83
LEAD	88	92	90
SELENIUM	0	0	0
ZINC	82	77	80
COLOR	84	59	72
FOAMING AGENT	57	52	55
TURBIDITY	54	67	51

A1 = primary treatment

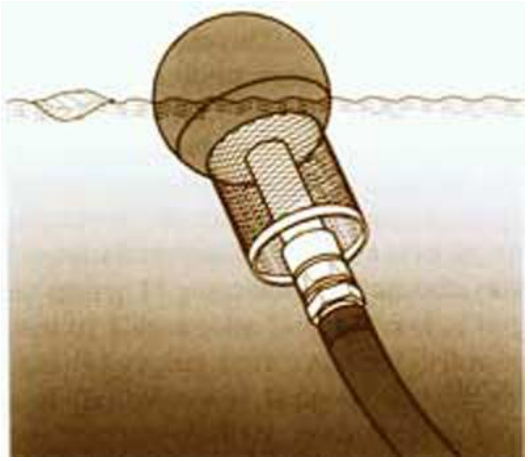
B1 = alum addition to effluent

0 = no significant removal

REF: WASTE WATER REUSE AND RECYCLE TECHNOLOGY by GORDON CULP, GEORGE WESNER, ROBERT WILLIAMS and MARK V HUGHES Jr.

To carry out water from this chamber to the next, a specially designed intake pipe is provided. It ahs a ball like structure to float in water so that it collects water from the upper level only and

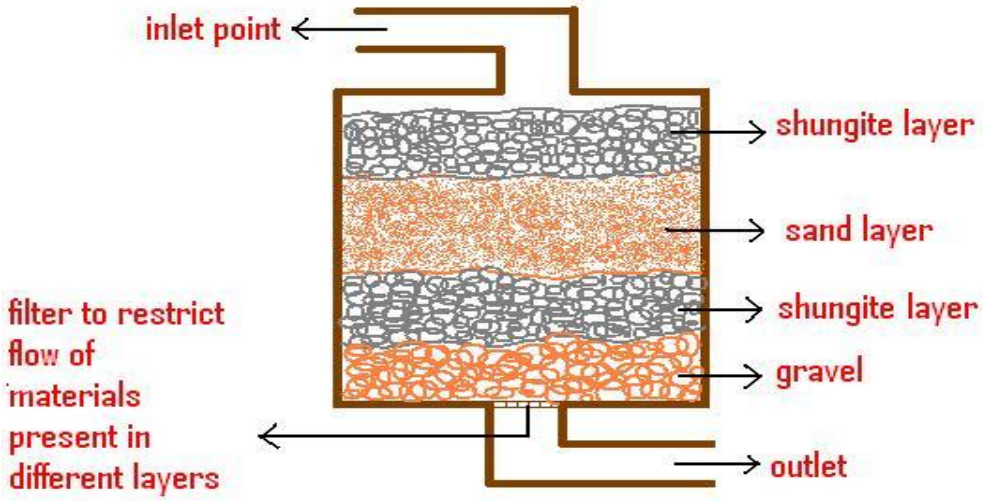
that also after filtering it so that the impurities that are skimmed can be restricted. It starts collecting water only after water level reaches a certain height in the tank in order to assure that proper sedimentation takes place. Through this intake pipe water is carried to the last chamber of the filtration system. Fig. of the inlet pipe is as shown.



The last chamber, which is the most crucial one, performs the job of removing organic soluble substances and one of the most crucial elements present in the house hold waste that can pollute water easily and severely. These elements are the SURFACTANTS that are present in a sound amount in the house hold waste. Though the foaming agents are removed in the steps 1 and 3, but it is not removed completely or to such an extent that water can be directed underground

The chamber is more or less similar to that used in 1st step except the arrangement of layers and presence of most influencing, a natural material 'SHUNGITE'.

The chamber is as



shown.

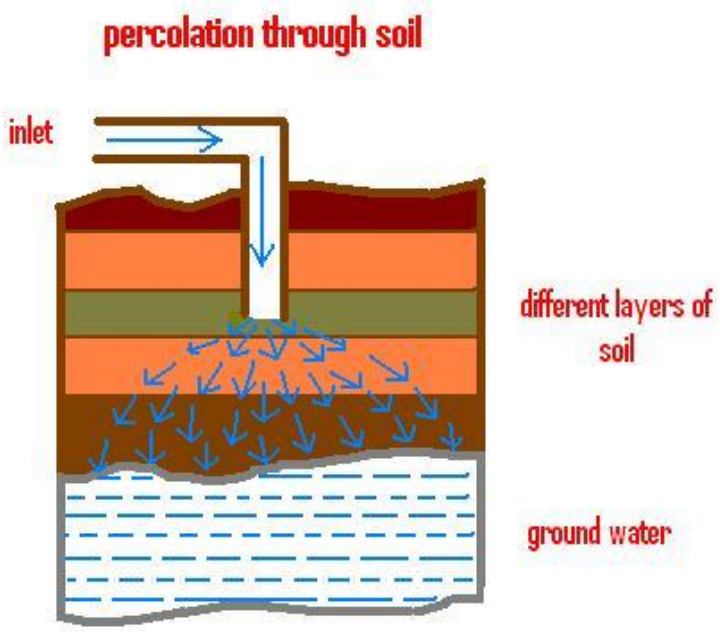
SHUNGITE is a natural carbonaceous mineral, abundant in Russia. Their properties are current under studies and applications are continuously growing. It is elementary Carbon with amorphous structure. SHUNGITE contains 30% carbon (by mass) and following additional compounds: SiO2 (60%), Al2O3 (3.5%), Fe2O3 + FeO (2%), TiO2(0.2%), MgO +CaO (1%) and K2O + Na2O (1%). Globular and ellipsoidal multilayer nanoparticles with size between 6 – 10 nm, having inner cavities are structure forming element of SHUNGITE carbon.

SHUNGITE is elementary non crystalline carbon with a metastable structure incapable of graphitization. It is an amorphous carbon mineral containing widely dispersed silicate grains. The peculiarity of HSUNGITE carbon structure is known to be the existence of an interpenetrating network between two phases carbon and silica, which are the main constituents of the SHUNGITE rock. It is also used s a term to describe a sequence of metamorphic from the Karelia region of Russia containing such carbon

A continued pollution of water is connected with the distinct colloido-chemical property of surfactants, namely their surface activity or ability to form foams, emulsions and micelles, as well as their ability to form structures in the volume and stabilize other pollutants in water.

Micelle forming surfactant detergents (anionic sodium dodecylsulfate SDS, cationic cetyltrimethylammonium bromide CTAB and non-ionic Triton X-100) can be adsorbed effectively using the SHUNGITE carbon. Specific use of SHUNGITE is due to the reason that some other good adsorbent, such as AL2O3 is effective for adsorbing cationic CTAB, but for SDS and TRITON X – 100, it is non-effective.

In this chamber top layer comprises of sand followed by gravel and finally by a layer of SHUNGITE. One layer of SHUNGITE can also be provided on top for more effective adsorption. Water is then carried away to a pipe that is bored halfway to the level of ground water after which water is allowed for natural percolation through the layers of different types of soil which itself is a very effective natural filter.



CHAPTER 4

MAINTENANCE

MAINTENANCE

From maintenance point of view, this system is not a hectic one and needs not require frequent inspection. To fulfill the demand of ALUM in the system, one has to just fulfill the ALUM BAGS with powdered alum. As the ALUM is dissolved from the perforated bag, it gets refilled by its own with the alum lying in the ALUM BAGS.

To clean up the whole system, a process required to be done hardly twice or thrice in 6 months, one should first direct the waste water flow to sewer with a valve that can be provided just before the inlet point of the system.

To clean the first chamber, one can either replace whole constituents, as they are natural and abundantly available, or can use the same material by washing it with a jet of clean water. Similarly the membrane or the sponge, if in a condition to be reused, can be cleaned up by applying a jet of clean water on the side opposite to that facing oily water, else it can be replaced. To clean water tank one has to just remove the sediments deposited at the bed which can be carried out easily using hoe. Finally cleaning of the last chamber of the system is more or less same as that of first chamber except cleaning of SHUNGITE. The adsorbed material from the SHUNGITE can be cleaned up by just heating the element which can be carried out artificially or by leaving the material in Sun for a sufficient period of time. In order to run the system continuously one would have an option of keeping two lots of SHUNGITE, so that when one lot is removed and kept in Sun, another one could be installed at its place

CHAPTER 5

COMMERCIAL IMPLEMENTATION

COMMERCIAL IMPLEMENTATION

The system will be economically sound. There is just one time nominal investment required. Also the maintenance cost will be so nominal that it won't put any extra burden on the house holder. For a single storied building and an average sized family, the total initial cost of the system will be about 9-10 thousand only. If this system is used, we can very easily tackle the problem of depletion of ground water level. It is very clear that in the coming future this problem will become more and more severe and some effective effort is needed in this direction. If we look at other alternatives, we have a method to recharge ground water by collecting water in some catchment area and then allowing the water to percolate by its own. But for this procedure we need a large area for catchment of water. Availability of such large area in a residential area, where shortage of land for more houses is itself a big problem, is practically impossible. Also we can't allow the house hold waste water to percolate without any primary treatment. It can be implemented as a law that no housing plan will be passed without the presence of this system. If this is done, government can influence in the trading of SHUNGITE ore and thereby making it cheaper in the Indian markets. Further the materials that are required in each chamber can be launched in the market as a set of all constituents for a particular chamber, depending upon the size of the chamber and that also in a very reasonable rate. Also SHUNGITE will make the cost minimum because if we want to use the same system by replacing SHUNGITE with some other material that is present in India, we have to go for the activated Charcoal. Major drawback of using activated Charcoal is that once the activation is over, we have to reactivate the Charcoal, which again is practically very difficult for normal people because the activation can't be done at home and one has to go to such a place where reactivation can done.

Thus the system mentioned here is the most economical and easies way to tackle the problem concerned with ground water and that also on a large scale.

CHAPTER 6

SIGNIFICANCE OF THE SYSTEM

SIGNIFICANCE OF THE SYSTEM

Cost will be very nominal and also the maintenance period would be sufficiently long to avoid frequent inspection. Thus no significant effort would be required from the house holder. Further there will be a continuous process of replenishing ground water and we need not to rely completely on rain water. Also, this water replenishing system would be much more economically viable and effective when employed on a scale of residential colonies as a whole.

Since there would be a recharge system working in each house in a residential area, the continuous fall in ground water level can be effectively checked. Further this system can be installed in apartments, colonies, bungalows etc. with some preferable changes, it could also be installed in schools. Thus it can play a vital role in balancing the Ecosystem.

CHAPTER 7

ALTERNATIVES USED

ALTERNATIVES USED

7.1) Due to unavailability of SHUNGITE, activated charcoal was used in the fourth stage of filtration. Activated charcoal, also called activated carbon or activated coal is a form of carbon that has been processed to make it extremely porous and thus to have a very large surface area available for adsorption or reaction. Due to its high degree of micro porosity, just one gram of activated carbon has a surface area of approximately 500 square meters. Sufficient activation for useful application may come solely from the high surface area, though further chemical treatment often enhances the adsorption properties of the material.

POWDERED ACTIVATED CARBON (PAC):

Traditionally, active carbons are made in particular form as powders or fine granules less than 1.0 mm in size with an average diameter between .15 and .25 mm. Thus they present a large surface to volume ratio with a small diffusion distance. PAC is made up of crushed or ground carbon particles, 95–100% of which will pass through a designated mesh sieve or sieve. Granular activated carbon is defined as the activated carbon being retained on a 50-mesh sieve (0.297 mm) and PAC material as finer material, while ASTM classifies particle sizes corresponding to an 80-mesh sieve (0.177 mm) and smaller as PAC. PAC is generally added directly to other process units, such as raw water intakes, rapid mix basins, clarifiers, and gravity filters.

PHYSICAL AND CHEMICAL PROPERTIES:

Appearance: Fine black powder.

Odor: Odorless.

Solubility: Insoluble in water.

Specific Gravity: 1.8 - 2.1

pH: 5.0-10.0

% Volatiles by volume @ 21C (70F): 0

Boiling Point: Sublimes.

Melting Point: 3550C (6422F)

Vapor Density (Air=1): 0.4

Vapor Pressure (mm Hg): 1 @ 3586C (6487F)

Evaporation Rate (BuAc=1): No information found.

POTENTIAL HEALTH EFFECTS:

Inhalation: No adverse effects expected. May cause mild irritation to the respiratory tract.

Ingestion: No adverse effects expected. May cause mild irritation to the gastrointestinal tract.

Skin Contact: Not expected to be a health hazard from skin exposure. May cause mild irritation and redness.

Eye Contact: No adverse effects expected. May cause mild irritation, possible reddening.

Chronic Exposure: Prolonged inhalation of excessive dust may produce pulmonary disorders.

7.2) Sample to be tested is prepared in the laboratory instead of collecting from a suitable site. List of chemicals added is:

Serial no.	Salt	Amount (gm)
1.	Sodium Nitrate	100.00
2.	Potassium Chromate	20.00
3.	Ammonium Chloride	50.00
4.	Copper II Sulfate Pentahydrate	30.00
5.	Iron (II) Sulfate hyptahydrate	30.00
6.	Potassium dihydrogen Phosphate	50.00
7.	Cadmium Nitrate	20.00
8.	Lead Nitrate	1.5
9.	Zinc Sulfate	200.00

7.3) Second stage, which is an optional one, was not included while conducting the experiments.

7.4) Alum was added to water manually just before stage three got started. Concentration of alum was kept to be 20mg/l.

CHAPTER 8

ACTUAL EXPERIMENTAL SETUP

ACTUAL EXPERIMENTAL SETUP

The filter required for the first stage was assembled in a box made up of perplexes material, which is transparent in nature. The dimension of the box was 0.5m X 0.5m X 0.6m.

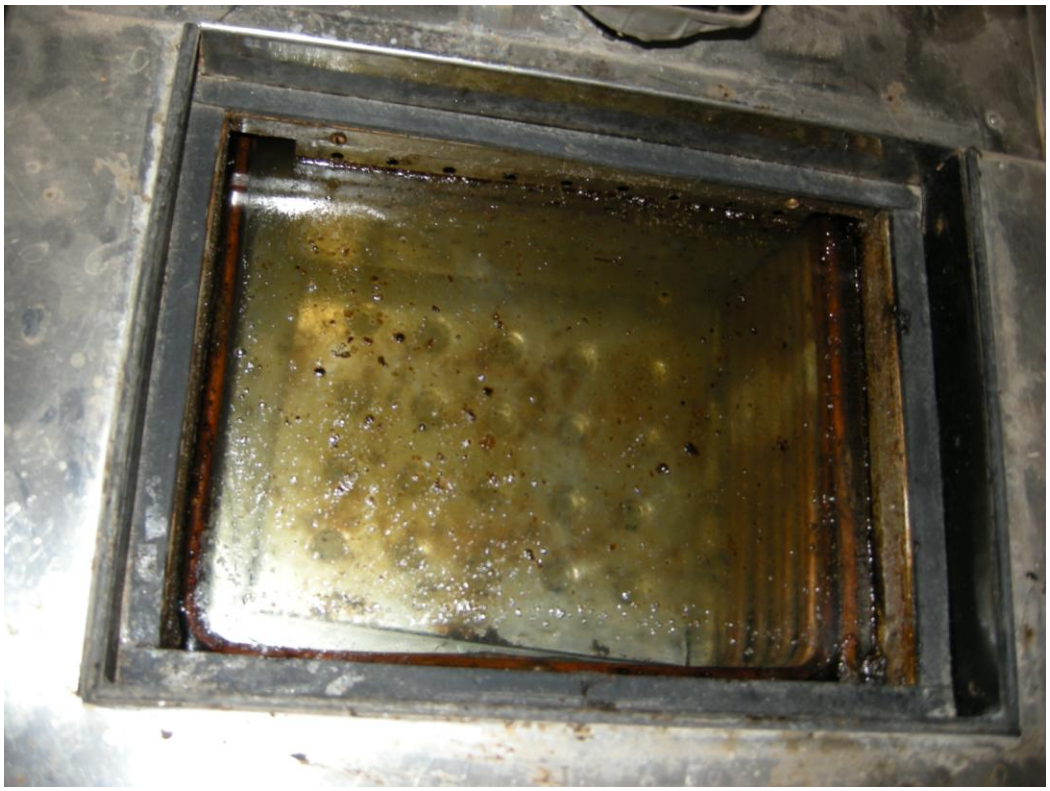
The grain size of the sand used as a filtering media was taken to be in a range of 450µ-220µ, i.e. passing from 450µ sieve but retained in 220µ sieve. For supporting media, pebbles of size 1.5cm-2.5cm were used, which were collected from the banks of the river Koel.

Amount of sand required was about 200kg (or four sand bags), whereas about half of a sandbag of pebbles (0.0125 cubic meter) was required.

Actual setup is as shown below

Bottom most layer was made up of pebbles. Depth of this layer was kept to be about 10cm-12cm. above it was a layer of sand which continued up to the top most level of the filter, thus providing a sand layer of about 48cm-50cm. A sheet of filter paper was provided at the bottom most part of the box to restrict any passage of fine sand through the holes provided at the floor of the box to collect water from the filter.

In the third stage, alum was mixed manually to the water that has been collected after the completion of stage one. Concentration of alum was kept to be about 20mg/l. This water was allowed to stagnate for a few days in a tank as shown in the following picture.



In the last stage of the filter, as mentioned above, activated charcoal was used in place of SHUNGITE. Depth of the supporting pebble layer was about 5cm, above which was a layer of activated charcoal. About 5kg of activated charcoal was used in this stage. A layer of about 10cm-15cm of activated charcoal was required for this stage. Since the amount of activated charcoal available was not sufficient enough to maintain a layer of such depth, the filter was separated into three parts using thermacoal as separating medium and plastic sheets to make each compartment water proof. Thus the effective filter was assembled in only one fourth part of the original filter. In this part, depth of the supporting pebble layer was maintained to be 5cm-7cm. depth of the activated charcoal layer was maintained to be about 15cm-17cm and above it was a layer of sand of the same grade as that used in the first stage. This layer of sand continued up to the top most level of the filter. Filter papers were provided between pebbles and activated charcoal layer and also between sand and activated charcoal to avoid any mixing of these materials. Also a filter paper was provided at the bottom most part of the filter to restrict any passage of sand through the holes, which were provided at the floor of the box to collect water from the filter.

CHAPTER 9

EXPERIMENTS CONDUCTED

9.1)

DETERMINATION OF OIL AND GREASE

Oil and grease is defined as any material recovered as a substance soluble in the solvent. It includes other material extracted by the solvent from an acidified sample (such as sulfur compound, certain organic dies and chlorophyll) and not volatilizes during the test.

REAGENTS:

1. Sulfuric acid (1:3) one part of sulfuric acid and three parts of water
2. Petroleum ether
3. Ethyl alcohol

PROCEDURE:

1. 200 ml of sample is taken in a separating funnel, and 10ml of sulfuric acid and 25ml of ether was added.
2. Sample is shake properly and is kept for some time to separate the two distinct layers, the upper one of the petroleum ether and lower one of the sample.
3. Lower layer is discarded through separating funnel.
4. A pre weighed small beaker is taken and the petroleum ether from the separating funnel is run through a filter paper which is already been moistened with fresh petroleum ether.
5. A little more petroleum ether is added through the wall of filter paper to remove any residual oil and grease on the filter paper.
6. Petroleum ether is evaporated on a water bath and final weight is taken, after cooling in a desiccator.

CALCULATIONS:

Oil and Grease mg/l = ((A – B) * 1000)/V

A = final weight of disc

B = initial weight of disc

V = volume of sample in ml

OBSERVATION AND READINGS:

Sample no.	Amount of sample (ml)	Initial weight (gm)	Final weight (gm)	Oil and grease (mg/l)	Percentage removal
1.	200	33.14	33.63	2.450	-
2.	200	47.05	47.18	0.65	73.46
3.	200	64.05	64.08	0.15	76.92

9.2)

DETERMINATION OF ALKALINITY

Alkalinity of water is the capacity of water to accept protons. It may be defined as the quantitative capacity of an aqueous medium to react with hydrogen ions..

REAGENTS:

1. Distilled water
2. Standard solution of sulfuric acid – 0.02N
3. Phenolphthalein indicator
4. Methyl orange

PROCEDURE:

1. 20ml of sample is pipette in a beaker.
2. 3 drops of phenolphthalein indicator is added. If slightly yellow color appears, sample is titrated with standard sulfuric acid solution until the color disappears.
3. 3 drops of methyl orange is added and sample is titrated with standard sulfuric acid solution until a tinge of pink color appears. Amount of standard sulfuric acid is noted down.

CALCULATION:

Total alkalinity (as mg/l of $CaCO_3$) = ((A + B)*N*5000)/V

A = ml of standard sulfuric acid used in titration in step 2.

B = ml of standard sulfuric acid used in titration in step 3.

N = normality of acid used.

V = volume of sample in ml.

OBSERVATION AND READINGS:

Sample no.	A (ml)	B (ml)	Alkalinity mg/l of $CaCO_3$	% change
1	0	8.1	81	-
2	0	10.2	102	26.25 (increase)
3	0	5.5	55	46.07 (decrease)
4	0	8.9	89	61.81 (increase)

9.3)

DETERMINATION OF BOD

PROCEDURE:

1. Water is taken in an incubation bottle.
2. 4 capsules (4gm) of NaOH is kept at the neck of the bottle
3. A magnetic stirrer is kept inside the bottle which rotates continuously when kept inside the incubator
4. Bottle is capped with an air tight cap, attached with an electronic meter which records BOD at every 24 hours
5. Bottle is preserved in the incubator for 5 days
6. After 5 days, reading is noted down.

OBSERVATION:

Sample no.	BOD
1.	19
2.	13
3.	09
4.	05

9.4)

DETERMINATION OF DO

PROCEDURE:

1. Water is taken in an incubation bottle
2. Bottle is kept in an air incubator and magnetic stirrer is put in it which rotates continuously.
3. With the help of DO meter, readings are taken for the top, middle and bottom part of the bottle.
4. Average of these readings is taken which gives the DO present in the sample.

OBSERVATION AND READINGS:

Sample no.	DO at the top section	DO at the middle section	DO at the bottom section	Average DO
1.	1.99	2.05	2.02	2.02
2.	3.65	3.71	3.68	3.68
3.	4.91	4.99	4.96	4.95
4.	6.21	6.24	6.20	6.22

9.5)

DETERMINATION OF ph

PROCEDURE:

1. Water sample is taken in a beaker.
2. This beaker is then put in the ph meter and electrodes are completely dipped in water.
3. Reading is noted down from the meter
4. Same process is repeated for other samples

OBSERVATION AND READINGS:

Sample no.	Temperature	ph
1.	35.4	6.19
2.	35.3	7.74
3.	35.3	4.1
4.	35.5	6.8

9.6)

DETERMINATION OF TURBIDITY

PROCEDURE:

1. Nephelo meter is adjusted to zero reading for distilled water and range of measuring turbidity is selected.
2. Sample is taken in the small beaker provided with the nephelo meter.
3. Sample is covered with the lid provided
4. Reading is taken directly from the meter.
5. Same process is repeated for other samples.

OBSERVATION AND READINGS:

Sample no.	Turbidity (in NTU)	% Removal
1.	>1000	-
2.	150-180	>83.50
3.	40-60	69.69
4.	<8	88.00

CHAPTER 10

RESULTS

RESULTS

Percentage removal of several pollutants in the experiments conducted as compared to the theoretical values is as follows

Constituents of the sample are

Serial no.	Salt	Amount (mg/l)
1.	Sodium Nitrate	10.00
2.	Potassium Chromate	2.00
3.	Ammonium Chloride	5.00
4.	Copper (II) Sulfate Pentahydrate	3.00
5.	Iron (II) Sulfate hyptahydrate	3.00
6.	Potassium dihydrogen Phosphate	5.00
7.	Cadmium Nitrate	2.00
8.	Lead Nitrate	0.1
9.	Zinc Sulfate	15.00

Theoretical value of percentage removal in first stage is given below

CONSTITUENT	DATA SOURCE		AVERAGE
	A	B	
BOD	48	50	42
NH3-N	17	19	18
PHOSPHOROUS	27	26	27
ALKALINITY	+	+	+
OIL AND GREASE	67	63	65
ARSENIC	28	40	34
CADMIUM	30	45	38
CHROMIUM	+	44	44
COPPER	40	58	49
FLORIDE	+	X	X
IRON	43	42	43
LEAD	51	53	52
SELENIUM	0	0	0
ZINC	38	34	36
COLOR	18	12	15
TURBIDITY	31	30	31
FOAMING AGENT	30	38	34

+ = Increase

X= data inconclusive

0 = no significant removal

Percentage removal in the experiments conducted for the first stage

Serial no.	Constituents	Percentage Removal
1.	BOD	31.57
2.	NH3-N	-
3.	Phosphorous	-
4.	Alkalinity	26.25 (increase)
5.	Oil and Grease	73.46
6.	Arsenic	NA
7.	Cadmium	-
8.	Chromium	-
9.	Copper	-
10.	Fluoride	NA
11.	DO	82.18
12.	Iron	-
13.	Lead	-
14.	Selenium	NA
15.	Zinc	-
16.	Color	-
17.	Turbidity	>83.50
18.	Foaming Agent	-
19.	ph	25.04 (increase)

Theoretical value of percentage removal in third stage is given below

CONSTITUENT	DATA SOURCE		AVERAGE
	A1	B1	
BOD	80	72	76
PHOSPHOROUS	-	78	78
ALKALINITY	13	19	16
OIL AND GREASE	91	87	89
ARSENIC	32	54	83
CADMIUM	68	76	72
CHROMIUM	81	90	86
COPPER	82	90	86
FLORIDE	46	42	44
IRON	84	81	83
LEAD	88	92	90
SELENIUM	0	0	0
ZINC	82	77	80
COLOR	84	59	72
FOAMING AGENT	57	52	55
TURBIDITY	54	67	51

A1 = primary treatment

B1 = alum addition to effluent

0 = no significant removal

Percentage removal in the experiments conducted for the third stage

Serial no.	Constituents	Percentage Removal
1.	BOD	30.77
2.	NH3-N	-
3.	Phosphorous	-
4.	Alkalinity	46.07
5.	Oil and Grease	76.92
6.	Arsenic	NA
7.	Cadmium	-
8.	Chromium	-
9.	Copper	-
10.	Fluoride	NA
11.	DO	34.51 (increase)
12.	Iron	-
13.	Lead	-
14.	Selenium	NA
15.	Zinc	-
16.	Color	-
17.	Turbidity	69.69
18.	Foaming Agent	-
19.	ph	47.02

Percentage removal of some constituents in experiments conducted for stage four are

Serial no.	Constituents	Percentage Removal
1.	BOD	44.44
2.	Alkalinity	61.81 (increase)
3.	Oil and Grease	-
4.	DO	25.65 (increase)
5.	Turbidity	88.00
6.	ph	65.85 (increase)

CHAPTER 11

CONCLUSION

CONCLUSION

Values obtained for percentage removal of some constituents in experiments is quiet comparable to the theoretical values of percentage removal of those constituents.

Though the experiments were conducted only for some pollutants and about 50% were not experimentally checked, but by taking into account the comparability between the theoretical values and experimental values or remaining constituents, it can be concluded that the system works quiet effectively for these constituents and if only these constituents are considered, the filtered water has these constituents in a range that is safe enough to permit water to be directed underground.

CHAPTER 12

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REFERENCES

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